POTENTIAL EFFECTS OF SPILLWAY FLOW DEFLECTORS ON FISH CONDITION AND SURVIVAL AT THE BONNEVILLE DAM, COLUMBIA RIVER

Contract Number: DACW57-95-C-0086

PREPARED FOR:

U.S. Army Corps of Engineers
Portland District
Portland, Oregon

PREPARED BY:

Normandeau Associates, Inc.
1921 River Road, P.O. Box 10
Drumore, Pennsylvania 17518

John R. Skalski
Center for Quantitative Science
University of Washington
3737 15th Avenue, N.E. HR-20
Seattle, Washington 98195

and

Mid Columbia Consulting, Inc.
201 Cascade View Court
East Wenatchee, Washington 98802

APRIL 1996

EXECUTIVE SUMMARY

The U. S. Army Corps of Engineers (ACOE), Portland District, Oregon sponsored a study at Bonneville Dam to evaluate fish condition and survival of hatchery-reared chinook salmon, *Oncorhynchus tshawytscha* (100 to 170 mm, average about 124 mm total length) passed over spillbay equipped with flow deflectors (spillbay 4) and without flow deflectors (spillbay 2). Evaluation of fish survival and condition of chinook salmon depicting direct effects of spillbay passage under differing spillbay configurations are lacking in the literature. Additionally, ACOE requested a limited number (200 total) of juvenile chinook salmon be passed through the ice and trash sluices at Powerhouse 1 and 2 to obtain preliminary information on fish condition and to identify potential passage problems.

The study, utilizing the HI-Z Turb'N Tag-recapture technique (balloon tag), was conducted in October 1995 at water temperatures of 14.5 to 17.0°C (57.2 to 62.6°F) to estimate direct effects of spillbay passage. Survival probabilities and condition at 1 h and 48 h after release were estimated for fish passed through each spillbay at a spill of 12,000 cfs. The primary criteria set forth by the ACOE for a valid study were: ±5% precision level (ε) 90% of the time on each estimate; recapture rates ≥80%; recapture time <1 h; handling mortality <10%; use of small sample size; and quantification of the probable sources of fish injury/mortality. The study results met or exceeded these criteria.

Fish for the study were obtained from the Little White Salmon National Fish Hatchery, Washington. Treatment releases in both spillbays were 280 fish each with a matching control release of 280 fish. As in some recent studies, statistical analyses indicated that the release of a single control group for two treatment releases was a viable experimental protocol and reduced the sample size requirements.

Recapture probability for the two treatment groups were 0.961 and 0.993 and for controls it was 0.961; this combination of high recapture and control survival probabilities (>0.96) allowed the use of sample sizes as low as 280 fish without sacrificing precision. The slightly lower recapture

probabilities for control and spillbay 2 (0.961) treatment groups resulted from tag dislodgement and non-recaptures. Both spillbay 2 treatment fish and controls were released without the availability of flow from the adjacent spillbay 1 and some of the fish were swept toward the shore where they became entrapped in crevices of the shoreline rip rap and eddies making it difficult to retrieve. In contrast, spillbay 4 treatment fish tended to remain off-shore largely due to supplemental spill from spillbay 2.

Recapture times averaged <7.5 min for any release group. Statistical analyses revealed that recapture probabilities were homogeneous ($P>0.05$) for the flow deflector trials, but some variation occurred among the controls and non-flow deflector trials. Discharge from spillbay 1 would have likely improved recapture probabilities; however, additional flow from this spillbay could have interfered with efficiency of upstream passage of adult salmonids.

Survival probabilities and model parameters with their associated standard errors were calculated using the reduced model (H_O:P_A=P_D). The immediate (1 h) and 48 h survival probabilities were estimated at 1.0 for both treatment groups. Because of identical survival probabilities for both treatment groups, the potential effect of flow deflectors on fish survival could not be detected.

Even though the calculated survival probabilities were identical for both treatments some evidence of differences in injury type was observed. Four of 280 spillbay 2 (no flow deflector) treatment fish (1.4%) suffered eye injuries while only 1 of 280 (0.4%) at spillbay 4 (flow deflector) showed this injury type. However, relative to controls the overall injury rate was low (about 1.3%) in both treatment groups and few injuries were lethal over the 48 h period. One fish with an eye injury and another with descaling (75%) died. None of the treatment fish for spillbay 4 exhibited loss of equilibrium while four from spillbay 2 (1.4%) showed such an affliction; 1 control fish also exhibited loss of equilibrium.

Most of the observed injuries (bruises, injured eyes, small scrapes and cuts) appeared to be due

to physical contact with spillbay and tainter gate structural and other components. Obvious effects of pressure (e.g., expanded air bladder, entrapped gas bubbles, etc.) or shear (e.g., decapitation) were absent.

A small number (100 each) of fish was released to provide the general condition of juvenile salmon passed through the ice and trash sluices at Powerhouse 1 and 2 and to identify potential passage problems, if any. Powerhouse 1 sluice outfall appears to encourage predation on passed fish; radio tracking suggested at least 4 of 7 non-recaptured fish were preyed upon. However, it was unknown whether predation occurred on injured, alive, or dead tagged fish. No potential predation problem was identified at Powerhouse 2 sluice. However, the installation of the bulkhead at the end of Powerhouse 2 sluice raises the water level (approximately 10 ft) of the flume which diverts a portion of the flow into a side channel. This channel has a screened area that supplies auxiliary water to the adult fishway. The diverted flow carried some tagged fish into this side channel. Balloon tags from 4 of 10 non-recaptured fish during the study were located several weeks later by the station personnel in the adult collection channel during a maintenance inspection.

The fish injury rate was low at both sluices. Only 1 of 90 and 1 of 93 of the recaptured fish at Powerhouse 2 and Powerhouse 1, respectively, had an eye injury (hemorrhaged, bulging). One fish at Powerhouse 2 exhibited loss of equilibrium and died; none from the Powerhouse 1 sluice test died but one was descaled. The preliminary data from the two sluices suggests more in-depth monitoring may be warranted if the sluices are used as a downstream passage route by emigrating juvenile salmon.